

Case No.: AMKOR-028A



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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10-21-02

Applicant(s): Crowley, Sean T.
et al.

Group No.: 2827

Serial No.: 10/008,048

Examiner: Cruz, Lourdes C.

Filed: November 7, 2001

For: POWER SEMICONDUCTOR
PACKAGE WITH STRAP

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AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON D.C. 20231

Dear Sir or Madam:

In response to the Office Action mailed July 30, 2002, in relation to the above-identified patent application, please amend the application as follows:

In the Specification:

Please replace the paragraph beginning on page 7, line 21 and ending on page 7, line 27 with the following rewritten paragraph:

--The through hole 190 is useful during the process of molding the encapsulant material 194 about the package components. The through hole 190 permits passage of molten encapsulant material 194 from adjacent the first surface 186 of the cover portion 170 through the through hole 190 and into a region adjacent the second surface 188 of the cover portion 170. Permitting the molten

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encapsulant material 194 to pass through the hole 190 also helps prevent the strap 122 from being disconnected during the molding process. A portion of the encapsulant material 194 fills the through hole 190. --

Please replace the paragraph beginning on page 8, line 9 and ending on page 8, line 16 with the following rewritten paragraph:

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-- The first surface 186 of the cover portion 170 around the through hole 190 is not covered by the encapsulant material 194, but is exposed in and substantially coplanar and flush with the first surface 196 of the encapsulant material 194. The first surface 186 of the cover portion 170 radiates heat effectively to the exterior, since the first surface 186 is not covered with the encapsulant material 194. Such heat is typically generated at the die 102 and conducted through a thermal path including the flange portion 176 and the connection portion 174 of the strap 122 to the first surface 186 of the cover portion 170, where the heat may be dissipated from the first surface 186, such as by radiation. --

Please replace the paragraph beginning on page 8, line 17 and ending on page 8, line 21 with the following rewritten paragraph:

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-- Optionally, heat sink structures (not shown), including vertical protrusions, such as heat fins, heat pins, and the like may be attached to, or formed on, the first surface 186 of the

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cover portion 170 to provide additional heat dissipation capability to the package 100. The heat sink structures may be secured on the first surface 186 by a thermally conductive adhesive or thermal grease, for example. --

Please replace the paragraph beginning on page 9, line 11 and ending on page 9, line 15 with the following rewritten paragraph:

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-- Accordingly, this embodiment provides for multiple thermal paths for dissipation of heat generated at the die 102. Heat may be dissipated through the following exposed surfaces: the first surface 186 of the cover portion 170 of the strap 122, the second surface 126 of the die pad 104, the second surfaces 136 of the leads 106, the second surface 146 of the lead 114, and the second surfaces 160 of the leads 116-120, among other possibilities. --

Please replace the paragraph beginning on page 9, line 23 and ending on page 10, line 4 with the following rewritten paragraph:

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-- FIGS. 4-6 illustrate a semiconductor package 400 in accordance with another embodiment of the present invention. The semiconductor package 400 is similar to the semiconductor package 100 (FIGS. 1-3), and has common features, except as follows. Comparing FIGS. 4 and 5 to FIGS. 1 and 2, the first surface 186 of the cover portion 170 of package 400 is not exposed through the first surface 196 of the encapsulant material 194, but is

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encapsulated by the encapsulant material 194. Nonetheless, this embodiment provides for multiple thermal paths for dissipation of heat generated at the die 102. In this embodiment, heat may be dissipated through the following exposed surfaces: the second surface 126 of the die pad 104, the second surfaces 136 of the leads 106, the exposed surface 146 of the lead 114, and the second surfaces 160 of the leads 116-120. Of course, heat will also radiate through the thin layer of encapsulant material 194 over the first surface 186 of the cover portion 170 of the strap 122. --

Please replace the paragraph beginning on page 10, line 18 and ending on page 10, line 22 with the following rewritten paragraph:

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-- Package 700 provides multiple thermal paths for dissipation of heat generated at the die 102. Heat may be dissipated through the following exposed surfaces: the first surface 186 (FIG. 8) of the cover portion 170 of the strap 122, the second surfaces 136 (FIG. 9) of the leads 106, the second surface 146 (FIG. 9) of the lead 114, and the second surfaces 160 (FIG. 9) of the leads 116, 118, and 120, among other possibilities. --

In the Claims:

Please amend Claims 1, 12, 21, 23, and 24 as follows:

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1. (Amended) A semiconductor package, comprising:
a die;

a die pad having first and second surfaces, the die being mounted on the first surface of the die pad;

a plurality of leads, each of the leads having first and second surfaces, with at least some of the leads being integrally connected to the die pad;

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a conductive strap extending between and electrically coupling the die and the first surfaces of at least some of the leads which are not integrally connected to the die pad;

an encapsulant material encapsulating the die, at least a portion of the die pad, at least a portion of the conductive strap, and at least a portion of the first surfaces of the leads such that the second surfaces of the leads are exposed within and substantially flush with a horizontal exterior surface of the encapsulant material.

12. (Amended) A semiconductor package, comprising:

a die;

a die pad having first and second surfaces, the die being mounted on the first surface of the die pad;

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a plurality of leads, each of the leads having first and second surfaces, with at least some of the leads being integrally connected to the die pad;

a conductive strap extending between and electrically coupling the die and the first surfaces of at least some of the leads which are not electrically connected to the die pad;

an encapsulant material encapsulating the die, at least a portion of the die pad, at least a portion of the strap, and at least a portion of the first surfaces of the leads such that at least a portion of the strap is exposed through the encapsulant material, and at least a portion of the second surface of the die pad and the second surfaces of the leads are exposed within and substantially flush with a horizontal exterior surface of the encapsulant material.

21. (Amended) A semiconductor package, comprising:

a die;

a die pad having first and second surfaces, the die being mounted on the first surface of the die pad;

a plurality of leads, each of the leads having first and second surfaces, with at least some of the leads being integrally connected to the die pad;

a conductive strap extending between and electrically coupling the die and the first surfaces of at least some of the leads which are not integrally connected to the die pad;

an encapsulant material encapsulating the die, at least a portion of the die pad, at least a portion of the conductive strap, and at least a portion of the first surfaces of the leads such that the second surfaces of the leads are exposed within and substantially flush with a horizontal exterior surface of the encapsulant material;

each of the leads having a lead recessed portion adjacent to the exposed second surface thereof, wherein the encapsulant material fills the lead recessed portions;

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the die pad having a die pad recessed portion adjacent to the second surface thereof, the die pad recessed portion extending about the entire periphery of the second surface of the die pad, wherein the encapsulant material fills the die pad recessed portion.

23. (Amended) A semiconductor package, comprising:

a die;

a die pad having first and second surfaces, the die being mounted on the first surface of the die pad;

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plurality of leads, each of the leads having first and second surfaces, with at least some of the leads being integrally connected to the die pad;

a conductive strap extending between and electrically coupling the die and the first surfaces of at least some of the leads which are not integrally connected to the die pad;

an encapsulant material encapsulating the die, at least a portion of the die pad, at least a portion of the conductive strap, and at least a portion of the first surfaces of the leads such that at least a portion of the strap is exposed through the encapsulant material and the second surfaces of the leads are exposed within and substantially flush with a horizontal exterior surface of the

encapsulant material; and

a through hole formed in the exposed portion of the conductive strap, the encapsulant material filling the through hole.

24. (Amended) A semiconductor package, comprising:

a PMOSFET die;

a die pad having first and second surfaces, the PMOSFET die being mounted on and electrically coupled to the first surface of the die pad, wherein at least one source lead having first and second surfaces is integrally formed with the die pad;

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a plurality of drain leads, each of the drain leads having first and second surfaces;

a conductive strap disposed between the PMOSFET die and the first surfaces of the drain leads to electrically couple the PMOSFET die and the drain leads;

a gate lead electrically coupled to the PMOSFET die;

an encapsulant material encapsulating the PMOSFET die, at least a portion of the die pad, at least a portion of the conductive strap, at least a portion of the first surface of the source lead, and at least a portion of the first surfaces of the drain leads such that the second surfaces of the drain leads and the second surface of the source lead are exposed within and substantially flush with a horizontal exterior surface of the encapsulant material.

REMARKS

As a preliminary matter, submitted herewith for the Examiner's consideration are duly executed Power of Attorney documents wherein Applicant has transferred responsibility for the continued prosecution of the present application to the undersigned. Accordingly, Applicant respectfully requests that all future correspondence rendered in relation to the present application be forwarded to the undersigned.

The foregoing Amendment and remarks which follow are responsive to the Office Action mailed July 30, 2002, in relation to the above-identified patent application. In that Office Action, the Examiner objected to the drawings due to the use of the reference character "186" to designate both the first surface of the strap and the first surface of the cover portion. Additionally, the Examiner rejected Claims 1-29 under 35 U.S.C. §102(e) as being anticipated by the Lam et al. reference.

By this Amendment, Applicant has modified various paragraphs of the specification simply to clarify that the reference numeral "186" is used to designate the first surface of the cover portion 170 of the strap 122. These changes are consistent with the description set forth in those paragraphs of the originally filed specification beginning on page 6, line 20 and ending on page 7, line 3, and beginning on page 7, line 14 and ending on page 7, line 20. Applicant respectfully submits that the modifications to the

specification effectuated by this Amendment have overcome the Examiner's objection to the drawings.

In addition, Applicant has amended each of independent Claims 1, 12, 21, 23 and 24 to more clearly recite the novel and unobvious aspects of the present invention. More particularly, each of independent Claims 1, 12, 21 and 23 has been amended to describe at least some of the leads of the semiconductor package as being integrally connected to the die pad, with the conductive strap extending between and electrically coupling the die and the first surfaces of at least some of the leads which are not integrally connected to the die pad. In each of Claims 1, 12, 21 and 23, the encapsulant material is described as encapsulating at least a portion of the first surfaces of the leads such that the second surfaces of the leads are exposed within and substantially flush with a horizontal exterior surface of the encapsulant material.

Independent Claim 24 has been amended to describe the source lead integrally connected to the die pad as having first and second surfaces. As further recited in amended Claim 24, the encapsulant material encapsulates at least a portion of the first surface of the source lead and at least a portion of the first surfaces of the drain leads such that the second surfaces of the drain leads and the second surface of the source lead are exposed within and substantially flush with a horizontal exterior surface of the encapsulant material.

Applicant respectfully submits that independent Claims 1, 12, 21, 23 and 24 as amended are not anticipated or rendered obvious by the Lam et al. reference cited in support of the Section 102(e) rejection of Claims 1-29. As shown in Figures 6A-6F (relied upon by the Examiner) and described in the specification thereof, the Lam et al. reference discloses a semiconductor package having a die 110 which is mounted to the top surface of a heat sink 126. The heat sink 126 is formed to include an outwardly extending lip 128 which is formed about the periphery thereof. The semiconductor package further includes a leadframe 100 including a central portion 102 having cutouts 106 formed therein. The leadframe 100 also includes a lead 104. Both the central portion 102 and lead 104 are connected to tie bars 107, 109 which extend in spaced, generally parallel relation to each other.

As described in the Lam et al. reference, the central portion 102 of the leadframe 100 is attached to the source terminal 112 of the die 110 via an epoxy 124, with the lead 104 itself being attached to a gate terminal 114 of the die 110 via the epoxy 124. Subsequent to such attachment, the leadframe 100, die 110 and heat sink 126 are encased in a capsule 134 of injection-molded plastic. Portions of the leadframe 100 are not covered by the capsule 134 such that the removal or cutting of the tie bars 107, 109 subsequent to the formation of the capsule 134 results in the formation of multiple leads 130, 132. The spaces or gaps between

the leads 130 are defined by the cutouts 106 originally formed within the central portion 102. The leads 132 are themselves defined by the opposed ends of the lead 104 subsequent to the removal of the tie bars 107, 109. Those portions of the leads 130, 132 protruding from the capsule 134 are bent subsequent to the formation of the capsule 134 in the manner shown in Figure 6F.

In contrast, in each of independent Claims 1, 12, 21 and 23 as amended, at least some of the leads are described as being integrally connected to the die pad. Further, in each of amended Claims 1, 12, 21 and 23, the second surfaces of the leads are described as being exposed within and substantially flush with a horizontal exterior surface of the encapsulant material. Applicant respectfully submits that the structure in the Lam et al. reference most analogous to the die pad recited in Claims 1, 12, 21 and 23 is the heat sink 126. However, none of the leads 130, 132 is integrally connected to the heat sink 126. Nor are second surfaces of the leads 130, 132 exposed within and substantially flush with a common horizontal surface of the capsule 134. Rather, as clearly shown in Figure 6F, the leads 130, 132 protrude from respective ones of the longitudinal, vertical sides of the capsule 134. Though the leads 130, 132 are described as being bent such that the bottoms of the outer portions thereof are coplanar to make contact with a flat surface such as a printed circuit board, there is no teaching or suggestion of these outer portion bottoms being exposed

within and substantially flush with any horizontal surface of the capsule 134.

In the Office Action, the Examiner has characterized both the lead 104 and the leads 132 as satisfying the die pad element recited in Claims 1, 12, 21 and 23. Even assuming the characterization of the lead 104 as the die pad element does not represent a disfavored hindsight consideration of the teachings of the Lam et al. reference, there is still no teaching or suggestion therein of any of the leads 130 being integrally connected to the lead 104 or leads 132. Rather, the leads 130 are integrally connected to only the central portion 102 of the leadframe 100, which the Examiner characterizes as the conductive strap element of Claims 1, 12, 21 and 23.

Additionally, in certain ones of the pending claims of the application (e.g., Claim 7 and independent Claim 21), the die pad is described as including a recessed portion which extends about the entire periphery of the second surface thereof, the die being mounted to the opposed first surface of the die pad. In characterizing the lead 104 in the Lam et al. reference as satisfying the die pad element, these limitations simply cannot be satisfied. Referring to Figure 6B of the Lam et al. reference, assuming, arguendo, that the lead 104 satisfies the die pad element as the Examiner argues, the notches 120, 122 do not extend about the entire periphery of the lead 104, but rather along only two

opposed sides thereof. Moreover, that surface of the lead 104 along which the notches 120, 122 extend would have to be characterized as the second surface in order to satisfy the limitations in certain ones of the pending claims. However, in this case, the die 110 is also mounted to the second surface since that surface of the lead 104 adjacent the notches 120, 122 is the surface which is secured to the die 110 via the epoxy 124 (see Figure 6D). As a result, the limitation regarding the die being mounted to the first surface of the die pad (which is opposite the second surface having the recessed portion extending about the entire periphery thereof) is not satisfied. Along these lines, the Examiner has also characterized the cutouts 106 as satisfying the limitation in certain ones of the pending claims regarding the recessed portion within each of the leads for receiving encapsulant material. This characterization does not find support within the Lam et al. reference. As indicated above, the cutouts 106 are nothing more than holes in the central portion 102 of the leadframe which define the spaces between the leads 132 upon the removal of the tie bars 107, 109 from the leadframe 100. Thus, there is simply no basis to construe any cutout 106 as comprising an encapsulant receiving recessed portion within any one of the leads 130, 132.

Thus, Applicant respectfully submits that independent Claims 1, 12, 21 and 23 are in condition for allowance, as are Claims 2-

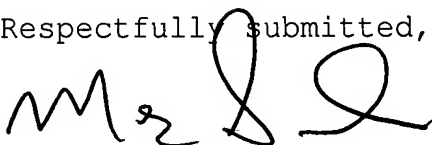
11, 13-20 and 22 as being dependent upon respective allowable base claims. Additionally, Applicant respectfully submits that independent Claim 24 as amended is also not anticipated or rendered obvious by the Lam et al. reference for the same reasons previously discussed in relation to Claims 1, 12, 21 and 23. As indicated above, in Claim 24 the source lead is described as being integrally connected to the die pad, with the second surface of the source lead and the second surfaces of the drain leads being exposed within and substantially flush with a horizontal exterior surface of the encapsulant material. As indicated above, none of the leads 130, 132 in the Lam et al. reference is integrally connected to the heat sink 126 which is the support member upon which the die 110 is mounted. Nor are any of the leads 130, 132 exposed within and substantially flush with a horizontal surface of the capsule 134. Rather, as also indicated above, such leads 130, 132 protrude from respective longitudinally extending, vertical sides of the capsule 134. Thus, Applicant respectfully submits that amended independent Claim 24 is also in condition for allowance, as are Claims 25-29 as being dependent upon an allowable base claim.

On the basis of the foregoing, Applicant respectfully submits that the stated objection and grounds of rejection have been

overcome, and that Claims 1-29 are now in condition for allowance.
An early Notice of Allowance is therefore respectfully requested.

Respectfully submitted,

Date: 9/30/02

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